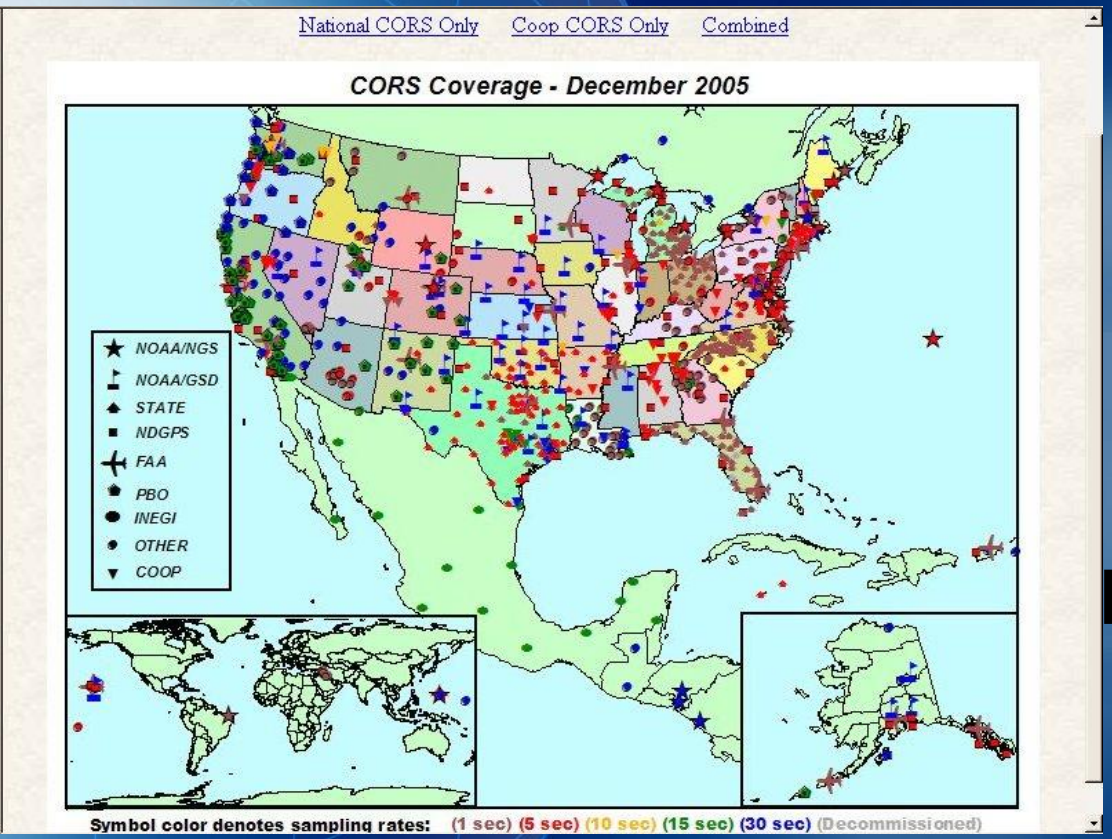
OPUS:

Online Positioning User Service

http://www.ngs.noaa.gov/OPUS/
ngs.opus@noaa.gov

WHAT IS OPUS?



- **O**n-line **P**ositioning **U**ser **S**ervice

- Fast & easy access to the NSRS (**National Spatial Reference System**) for GPS users

Areas Covered by OPUS

NATIONAL GEODETIC SURVEY

OPUS Upload | What is OPUS | Using OPUS | Recent Solutions | Faqs | OPUS Policies | Contact OPUS

Areas Covered by OPUS

OPUS will return a solution to you only if your position lies within one of the regions below.

Lower 48, Alaska &

Sur

Trinidad & Toba

Johns

Barbados

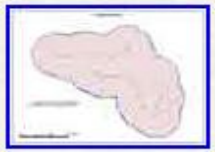
Curacao & Bonair

Anguilla

Dominica

Iraq

Jamaica & Pedro Cays



Kwajalein

Puerto Rico & Virgin Islands

Peru

National Oceanic an

How Does OPUS Work?

- Data submitted through NGS web page
- Processed automatically with NGS computers & software
- Position with respect to 3 suitable CORS (or IGS sites if 1) no NAD 83 positions are available and 2) the host country has an agreement with NGS. In these international cases, ITRF coordinates only are returned, and there are no state plane or US grid coordinates
- Solution via email (usually in minutes)

OPUS Guidelines

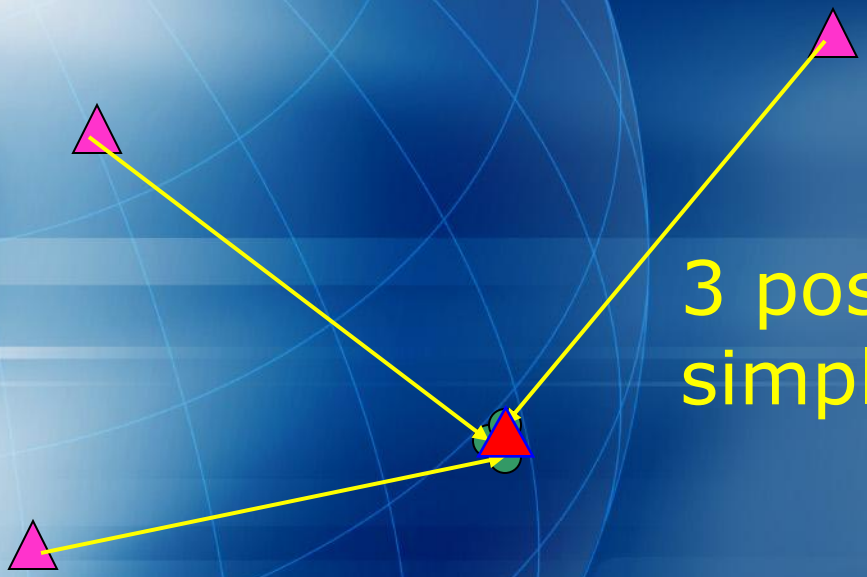
- Dual-frequency data (L1/L2)
- [recommended] Minimum 2 hrs of data (maximum 48—only cross midnight once)
- No kinematic or Rapid Static yet (OPUS-RS is under development)
- No Glonass. Galileo will be discussed as the constellation becomes available

Accurate height requires:

- correct antenna type
- correct antenna height

How Does OPUS Compute Position?

3 single baselines computed



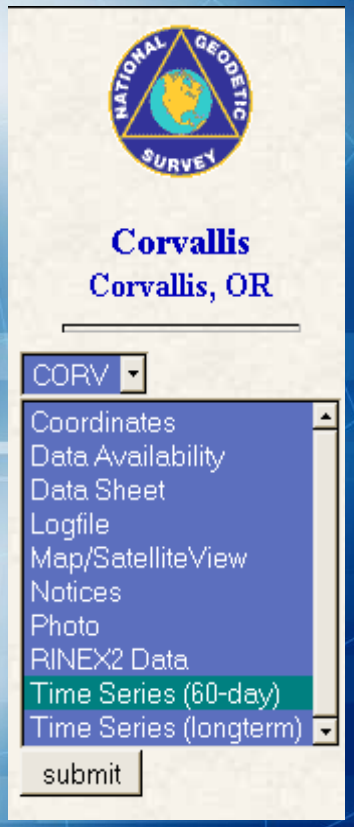
3 positions averaged — simple mean (equal weights)

Differences between positions include any errors in CORS coordinates

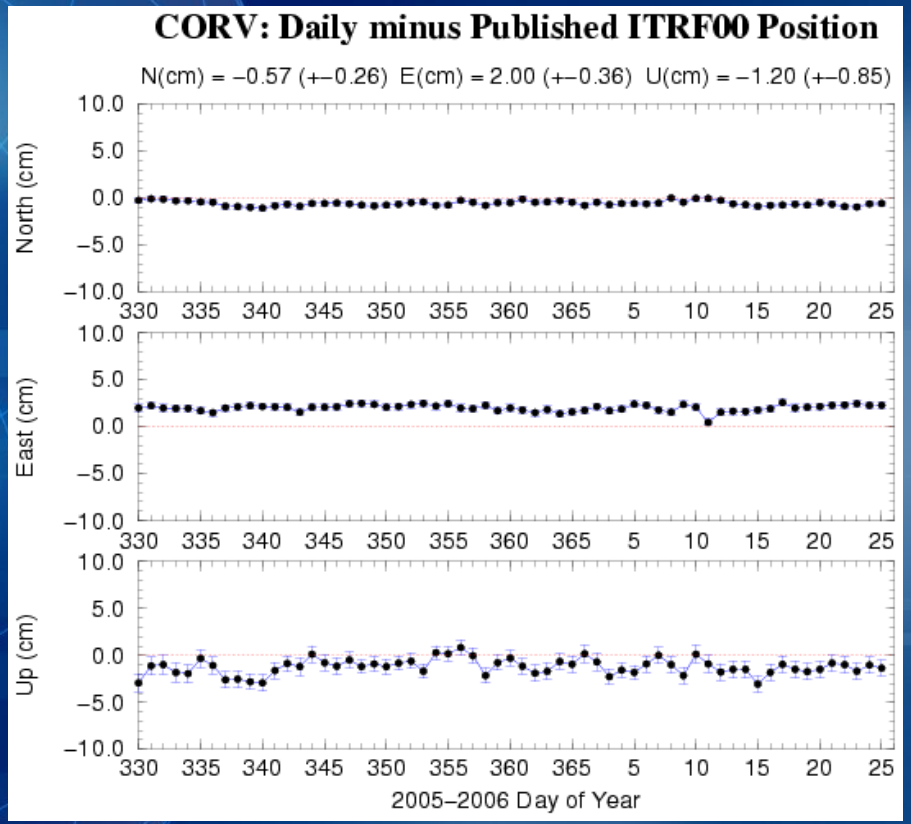
Time-series plots, 60-day and long-term

NATIONAL GEODETIC SURVEY

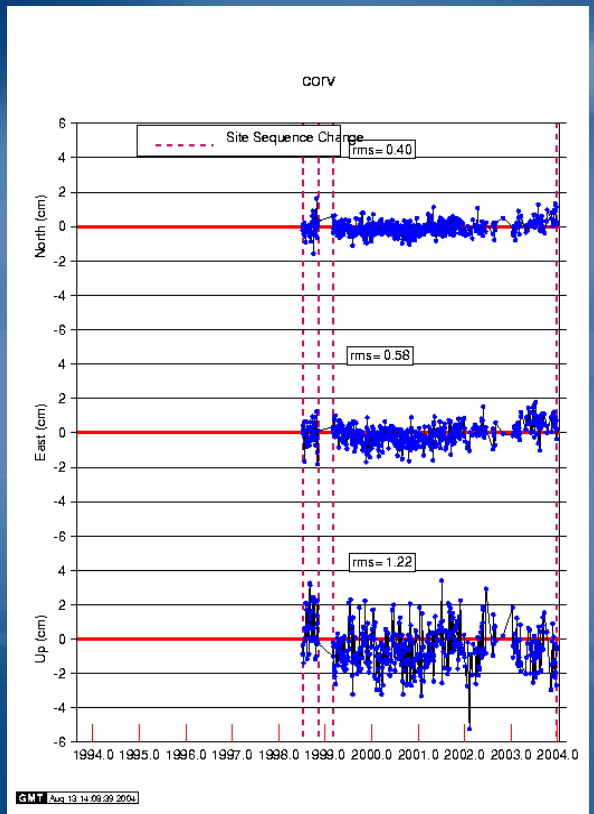
web page



60-day time series



Long-term time series



The time series plots provide a means of evaluating the small changes in position of a CORS.

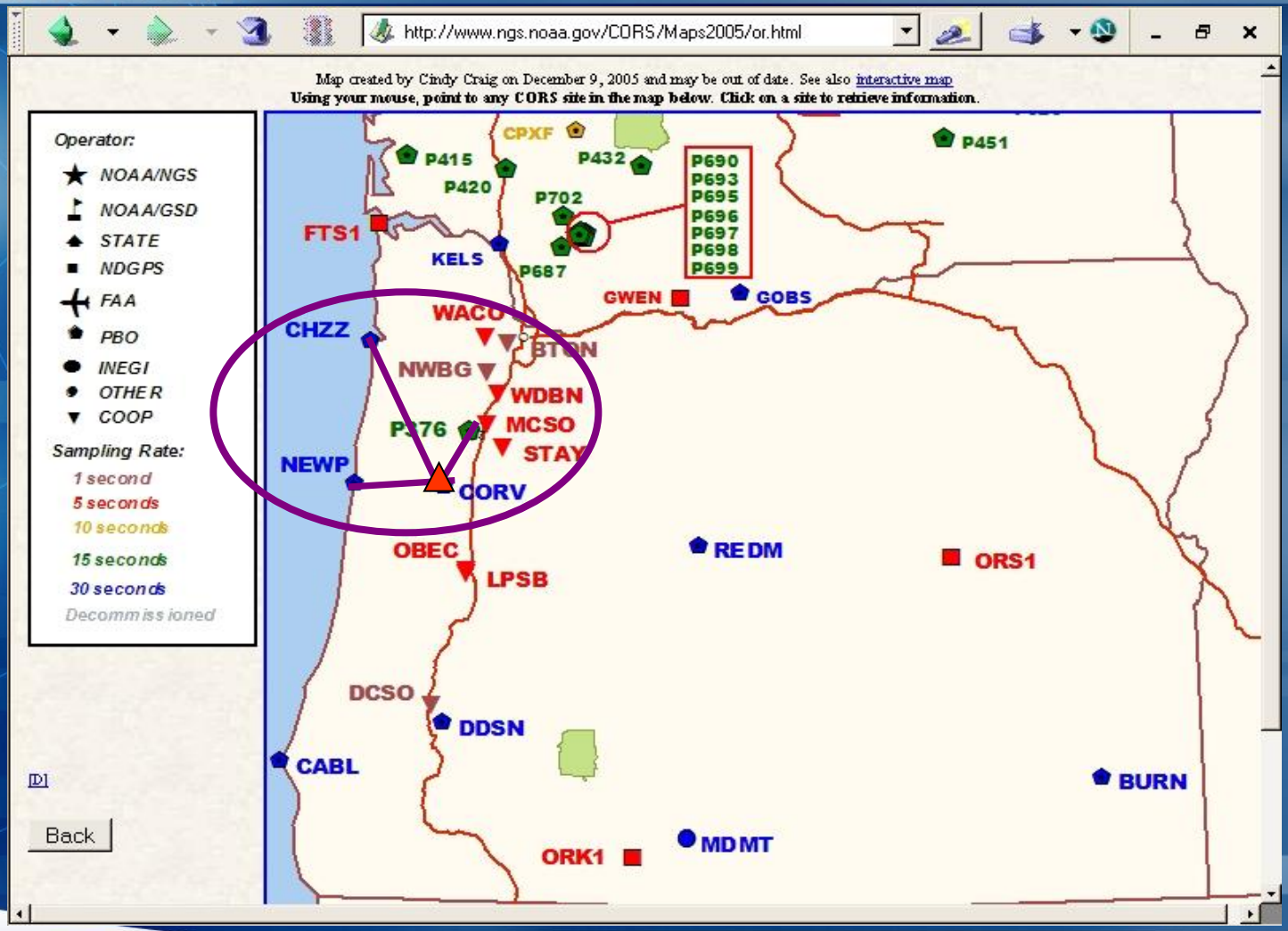
National Oceanic and Atmospheric Administration

How Does OPUS Pick Base Stations?

1. Estimate position for remote station
2. Compute distance to every available CORS
3. Sort CORS by increasing distance
4. Select the 5 closest CORS
5. Look at 1st 3 CORS with TEQC program. Criteria:
   - data cover time span for remote station
   - > 80% of data available
   - low multipath
   - if not, replace with 4th CORS (then 5th)
6. Start single baseline solutions using 1st 3 CORS
   - check solution quality
   - if bad solution, replace CORS with 4th (then 5th)

CORS Selection (example = CORV solved from CHZZ, NEWP, P376)

NATIONAL GEODETIC SURVEY



National Oceanic and Atmospheric Administration

U.S. DoC / NOAA / NOS / National Geodetic Survey - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

Address http://www.ngs.noaa.gov/

Go Links

Search Google AltaVista Ask Jeeves AlltheWeb LookSmart Customize this toolbar Highlight

mywebsearch Search Smiley Central My Info Fun Tools Games Customize My Button 1 Highlight

National Geodetic Survey

NGS, Positioning America for the Future

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

National Ocean Service

aeronautical data | CORS / OPUS GPS data | datasheets Find/Update a point | geodetic tool kit | PC software

Search for

Go

Site Map

What We Do

What's New

Products & Services

State Advisors

Contracting Opportunities

Our History

FAQ

Project & Division pages

Geoid

Geosciences Research (GRD)

Remote Sensing

FGCS/GIAC

Monday, March 15, 2004

• Upcoming Events • NGS In The News •

• *The Observer* Newsletter •

Check these out...

NGS Dedicates Commemorative Marker at U.S. Mint in Philadelphia: On March 12, NOAA dedicated a survey marker at the U.S. Mint in Philadelphia that commemorates Lewis and Clark's expedition across America two hundred years ago. ...*more info* ...Denver Mint dedication is March 15.

Cooperative CORS Providers/Users Group Meeting: The 2nd Annual Cooperative CORS Providers/Users Group Meeting will be held at the ACSM conference in Nashville. ...*more info*

New Options added to OPUS: This new version of OPUS optionally allows users control over which CORS sites are used for a solution, to receive their output in an extended format, and have their solution computed in State Plane coordinates. See Option #5 on the OPUS main page.

Lewis And Clark Bicentennial: To honor Lewis and Clark's contributions to mapping, NGS is installing a series of commemorative markers along the route that Lewis and Clark traveled.

The National Readjustment

NGS plans the readjustment of horizontal positions and ellipsoid

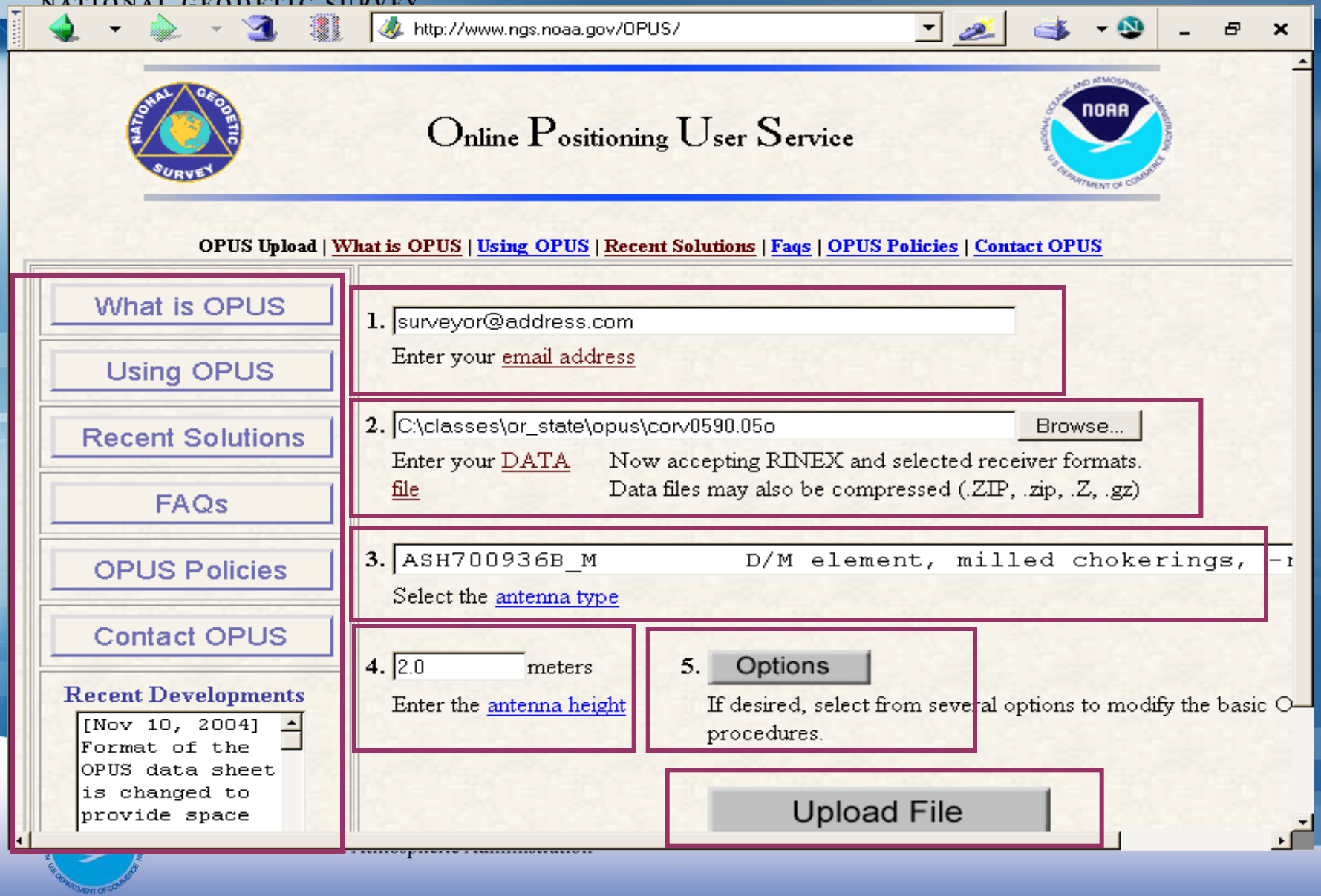
Quick Link to OPUS from NGS Home Page

www.ngs.noaa.gov

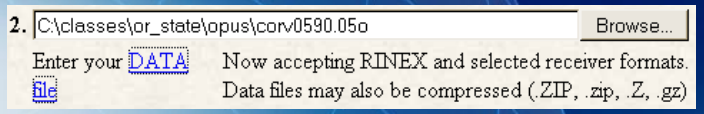
Done

Internet

Using the OPUS Web Page



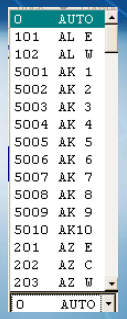
Allowable Data Formats



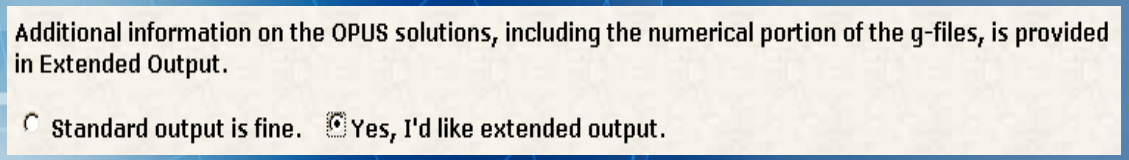
- RINEX Receiver Independent Exchange--uncompressed
- Manufacturer's native / raw (binary)—uncompressed--as long as UNAVCO's teqc program can process it
- Compressed archive of multiple files. Archive must contain RINEX "site123h.04o" or Hatanaka "site123h.04d"
- Compressed individual files."Site123h.zip"must contain "site123h.06o" or "site123h.06d"

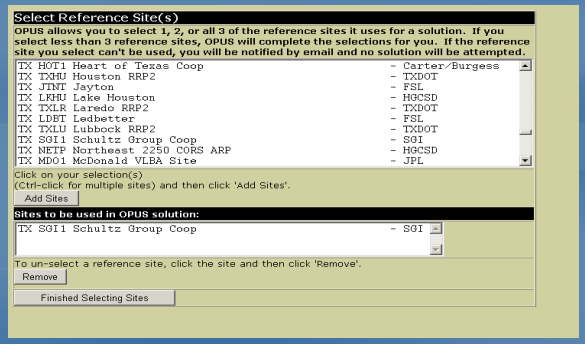
Options

NATIONAL GEODETIC SURVEY



- Select state plane coordinate zone
- Select or exclude base stations including Cooperative CORS
- Extended Output





- Set user profile

Associate antenna type, antenna height, SPC code, selected base stations and extended option choices with your email address

OPUS Output
Standard

NATIONAL GEODETIC SURVEY

National Oceanic and Atmosph

```
FILE: corv0590.05o 000416827

 1008   NOTE:  Antenna offsets supplied by the user were zero.  Coordinates
 1008   returned will be for the antenna reference point (ARP).
 1008

                              NGS OPUS SOLUTION REPORT
                              ========================

      USER: jeff.olsen@noaa.gov                    DATE: January 13, 2006
RINEX FILE: corv059f.05o                           TIME: 19:08:14 UTC


  SOFTWARE: page5  0601.10 master3.pl            START: 2005/02/28  05:00:00
 EPHEMERIS: igs13121.eph [precise]                STOP: 2005/02/28  06:59:30
  NAV FILE: brdc0590.05n                      OBS USED:  4228 /  4314   :  98%
  ANT NAME: ASH700936B_M    NONE            # FIXED AMB:    25 /    29   :  86%
ARP HEIGHT: 0.0                             OVERALL RMS: 0.013(m)

 REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)            ITRF00 (EPOCH:2005.1596)

         X:     -2498423.165(m)    0.018(m)          -2498423.872(m)    0.018(m)
         Y:     -3802822.048(m)    0.021(m)          -3802820.836(m)    0.021(m)
         Z:      4454737.695(m)    0.024(m)           4454737.792(m)    0.024(m)

       LAT:   44 35  7.91054      0.002(m)        44 35  7.92698      0.002(m)
     E LON:  236 41 43.48129      0.014(m)       236 41 43.42434      0.014(m)
     W LON:  123 18 16.51871      0.014(m)       123 18 16.57566      0.014(m)
    EL HGT:          107.485(m)    0.034(m)               107.108(m)    0.034(m)
 ORTHO HGT:          130.010(m)    0.043(m) [Geoid03 NAVD88]

                         UTM COORDINATES    STATE PLANE COORDINATES
                          UTM (Zone 10)         SPC (3601 OR N)
Northing (Y) [meters]     4936954.907           105971.557
Easting (X)  [meters]      475821.322          2277335.385
Convergence  [degrees]    -0.21381402          -1.98897497
Point Scale                0.99960719           0.99994603
Combined Factor            0.99959034           0.99992918

US NATIONAL GRID DESIGNATOR: 10TDQ7582136955(NAD 83)

                              BASE STATIONS USED
PID       DESIGNATION                        LATITUDE    LONGITUDE DISTANCE(m)
AH2489 NEWP NEWPORT CORS ARP              N443506.072 W1240342.736   60138.7
AJ6959 CHZZ CAPE MEARS CORS ARP           N452911.437 W1235841.187  113322.4
DH4503 P376 EOLARESVR_OR2004 CORS ARP     N445628.313 W1230608.100   42648.2

                     NEAREST NGS PUBLISHED CONTROL POINT
AH2486      CORVALLIS CORS ARP            N443507.910 W1231816.519       0.0
```

Reading OPUS Output

NATIONAL GEODETIC SURVEY

```
 USER: jeff.olsen@noaa.gov                    DATE: January 13, 2006
RINEX FILE: corv059f.05o                          TIME: 19:08:14 UTC

  SOFTWARE: page5  0601.10 master3.pl          START: 2005/02/28  05:00:00
 EPHEMERIS: igs13121.eph [precise]              STOP: 2005/02/28  06:59:30
  NAV FILE: brdc0590.05n                     OBS USED:  4228 /  4314   :  98%
  ANT NAME: ASH700936B_M    NONE          # FIXED AMB:    25 /    29   :  86%
ARP HEIGHT: 0.0                           OVERALL RMS: 0.013(m)
```

- Your email address & observation file. Solution run date & time
- The version of PAGES software used for processing
- The ephemeris used (OPUS will use the best available):
  "igs" final post-fit orbit--better than 1 cm (10-14 days wait)
  "igr" rapid post-fit orbit--better than 2 cm (17 hours wait)
  "igu" ultra-rapid predicted orbit--better than 20 cm (available immediately)
- Navigation file used
- The antenna type you selected and height of antenna reference point height you entered. Confirm that these are correct.

National Oceanic and Atmospheric Administration

Reading OPUS Output con't.


```
 USER: jeff.olsen@noaa.gov                    DATE: January 13, 2006
RINEX FILE: corv059f.05o                          TIME: 19:08:14 UTC

  SOFTWARE: page5  0601.10 master3.pl     START: 2005/02/28  05:00:00
 EPHEMERIS: igs13121.eph [precise]         STOP: 2005/02/28  06:59:30
  NAV FILE: brdc0590.05n                OBS USED:  4228 /  4314   :  98%
  ANT NAME: ASH700936B_M    NONE      # FIXED AMB:    25 /    29   :  86%
ARP HEIGHT: 0.0                       OVERALL RMS: 0.013(m)
```

- Start & end dates & times of your file
- Ratio and % of observations used in solution
- Ratio and % of fixed/total ambiguities
- Overall RMS of the solution

Guidelines for Good Solution

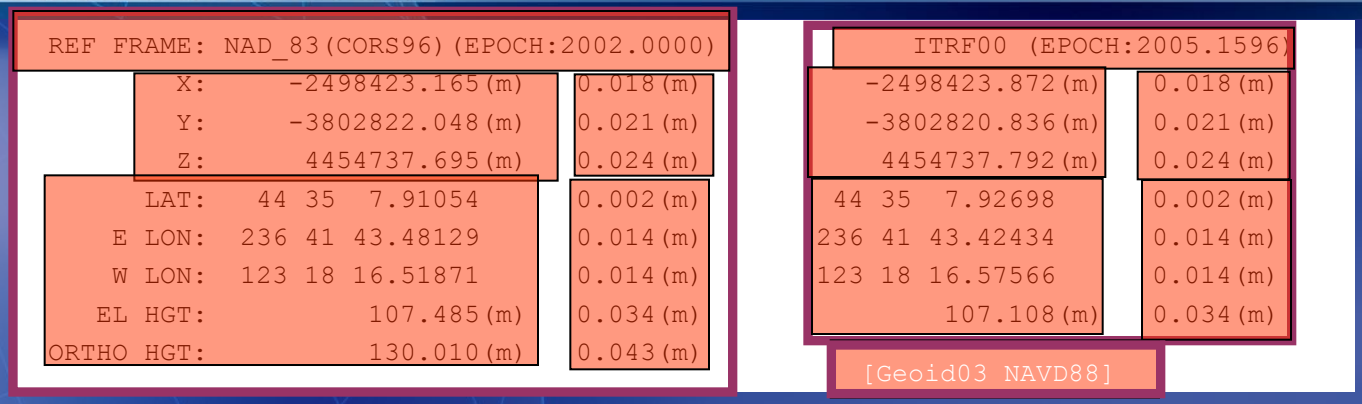
- Make sure antenna type and height are correct

- Review statistics:
  - at least 90% of observations should be used
    - OBS USED: 4228 / 4314 : 98%
  - at least 50% of the ambiguities should be fixed
    - # FIXED AMB: 25 / 29 : 86%
  - overall RMS should seldom exceed 0.030 m
    - OVERALL RMS: 0.013(m)

- In case of bad statistics, try choosing different CORS and re-submit.

Reading OPUS Output con't.
Solution/Coordinates

NATIONAL GEODETIC SURVEY

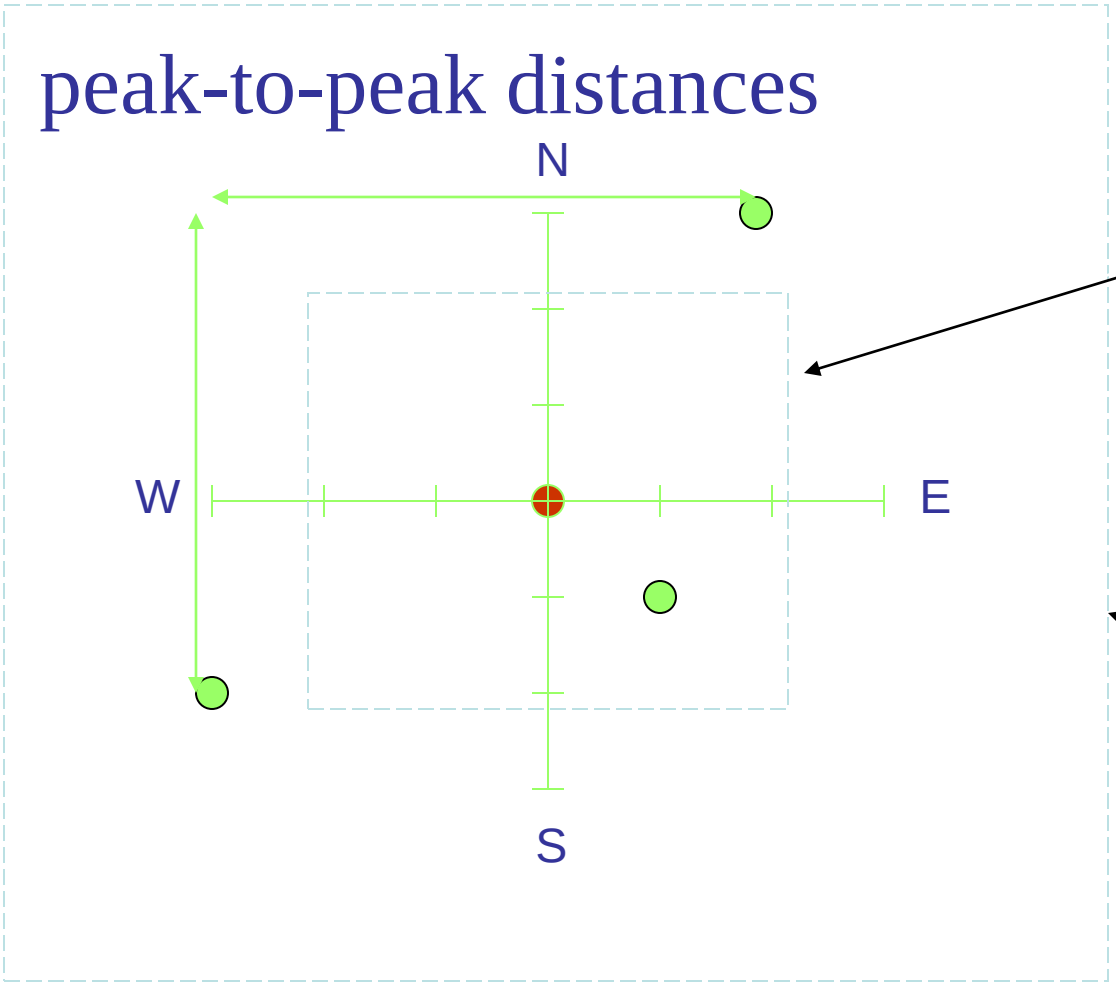


REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)		
X:	-2498423.165(m)	0.018(m)
Y:	-3802822.048(m)	0.021(m)
Z:	4454737.695(m)	0.024(m)
LAT:	44 35 7.91054	0.002(m)
E LON:	236 41 43.48129	0.014(m)
W LON:	123 18 16.51871	0.014(m)
EL HGT:	107.485(m)	0.034(m)
ORTHO HGT:	130.010(m)	0.043(m)

ITRF00 (EPOCH:2005.1596)		
	-2498423.872(m)	0.018(m)
	-3802820.836(m)	0.021(m)
	4454737.792(m)	0.024(m)
	44 35 7.92698	0.002(m)
	236 41 43.42434	0.014(m)
	123 18 16.57566	0.014(m)
	107.108(m)	0.034(m)
[Geoid03 NAVD88]		

- Reference frames. Epochs
- Position, xyz
- Peak-peak errors, xyz (range, max-min)
- Position, lat / long / eh / oh
- Peak-peak for lat/long etc
- Peak-peak errors may vary between NAD83 & ITRF
- Orthometric ht. is based on current geoid model

How Does OPUS Compute Errors?



OPUS Output con't.
Grid Coordinates

NATIONAL GEODETIC SURVEY

	UTM COORDINATES	STATE PLANE COORDINATES
	UTM (Zone 10)	SPC (3601 OR N)
Northing (Y) [meters]	4936954.907	105971.557
Easting (X) [meters]	475821.322	2277335.385
Convergence [degrees]	-0.21381402	-1.98897497
Point Scale	0.99960719	0.99994603
Combined Factor	0.99959034	0.99992918

US NATIONAL GRID DESIGNATOR: 10TDQ7582136955(NAD 83)

- Universal Transverse Mercator (UTM) coordinates
  - US National Grid
- State Plane coordinates (if requested)

READING OPUS OUTPUT (control)

NATIONAL GEODETIC SURVEY

```
•     BASE STATIONS USED
•    PID        DESIGNATION                        LATITUDE     LONGITUDE DISTANCE(m)
•    AH2489 NEWP NEWPORT CORS ARP                N443506.072 W1240342.736   60138.7
•    AJ6959 CHZZ CAPE MEARS CORS ARP             N452911.437 W1235841.187  113322.4
•    DH4503 P376 EOLARESVR_OR2004 CORS ARP       N445628.313 W1230608.100   42648.2

•                    NEAREST NGS PUBLISHED CONTROL POINT
•    AH2486      CORVALLIS CORS ARP              N443507.910 W1231816.519       0.0

•    This position and the above vector components were computed without any
•    knowledge by the National Geodetic Survey regarding the equipment or
•    field operating procedures used.
```

- Base Stations--NAD83 position--distance away
- The closest published station in the NGS data base

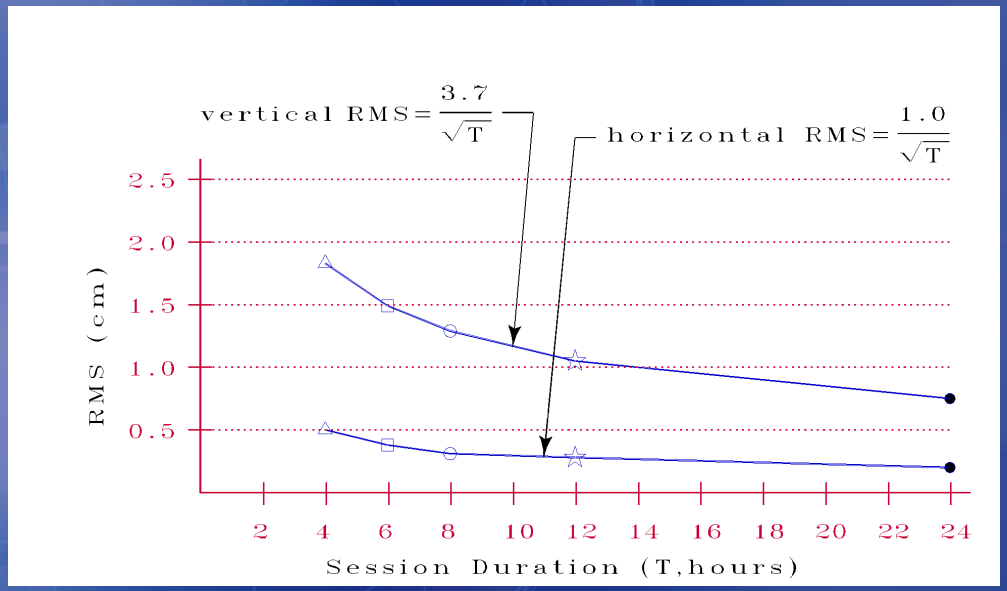
  In case you didn't know it was there

- Disclaimer

National Oceanic and Atmospheric Administration

How Can I Improve My Results?

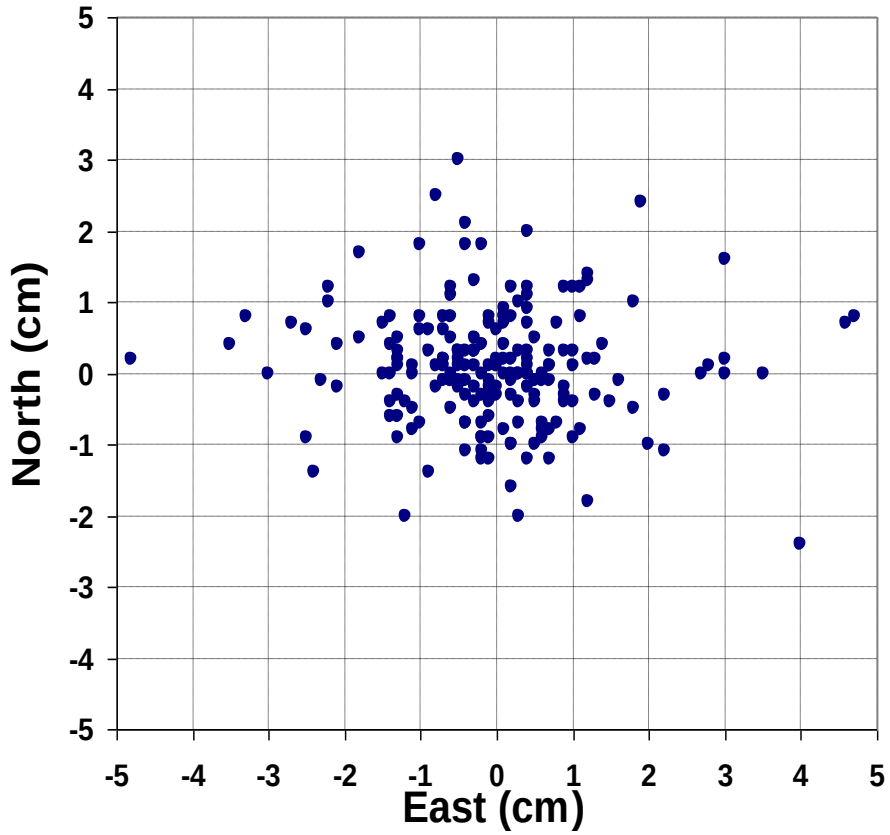
- Consider observing a longer session



- Data sets of at least four hours have been shown to produce more reliable results

- Avoid conditions that perturb the GPS signal—unsettled weather, solar flares, multipath (nearby reflective surfaces)

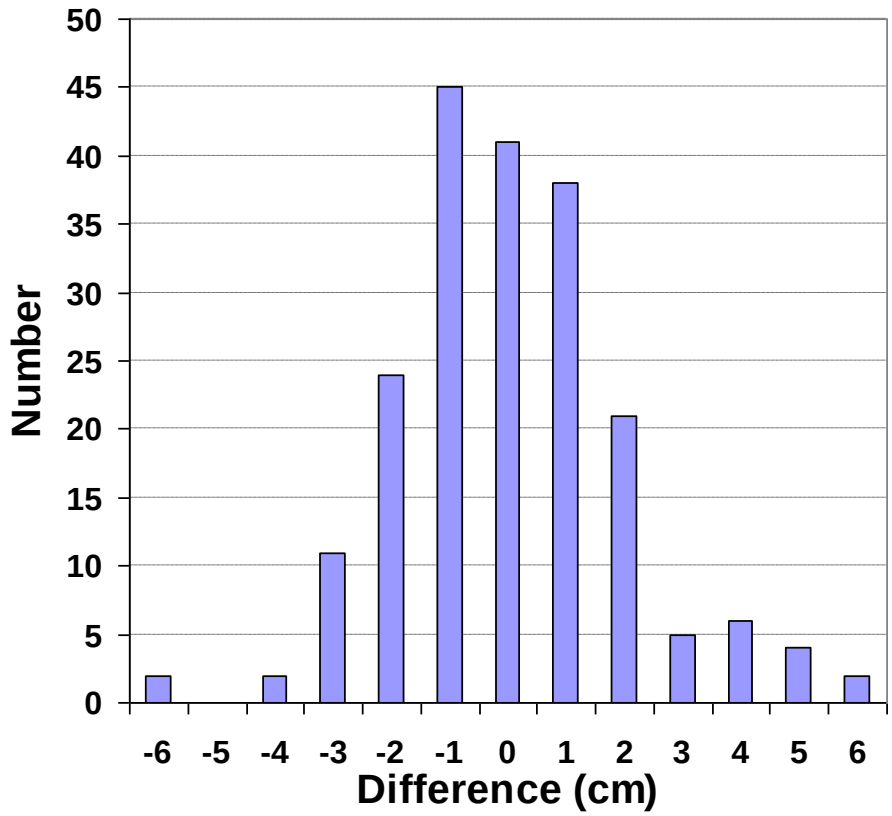
Distribution of Horizontal Offset from Accepted Values



- > 200 CORS
- 2 hours of data

- 0.8 cm N-S RMS
- 1.4 cm E-W RMS

Distribution of Vertical Offset from Accepted Values



- > 200 CORS
- 2 hours of data

- 1.9 cm RMS
- All mean offsets < 1 mm

Error Messages and Warnings

Resolution of the example messages below depends on circumstances. If there is a problem with software or hardware on the NGS side, sometimes just re-submitting the data file later is successful. If there is a problem with your data file, reobservation may be necessary.

"The OPUS positioning software is only available for use for datasets taken/recorded in one of the areas determined to be valid for OPUS A solution will not be performed on the dataset submitted.

The time span of the submitted dataset is too short. OPUS needs a minimum of one hours worth of data to begin processing.

The dataset submitted to OPUS does not meet the RINEX standard. Please re-submit the data in RINEX 2.0 or 2.1 standard. Aborting...

The dataset submitted to OPUS contained too many data gaps or a large number of sampling interval changes. Aborting...

WARNING! No antenna type selected. An antenna pattern will not be applied.

The observations to slip ratio is too low. There were an unusually high number of cycle slips in the dataset. Aborting...

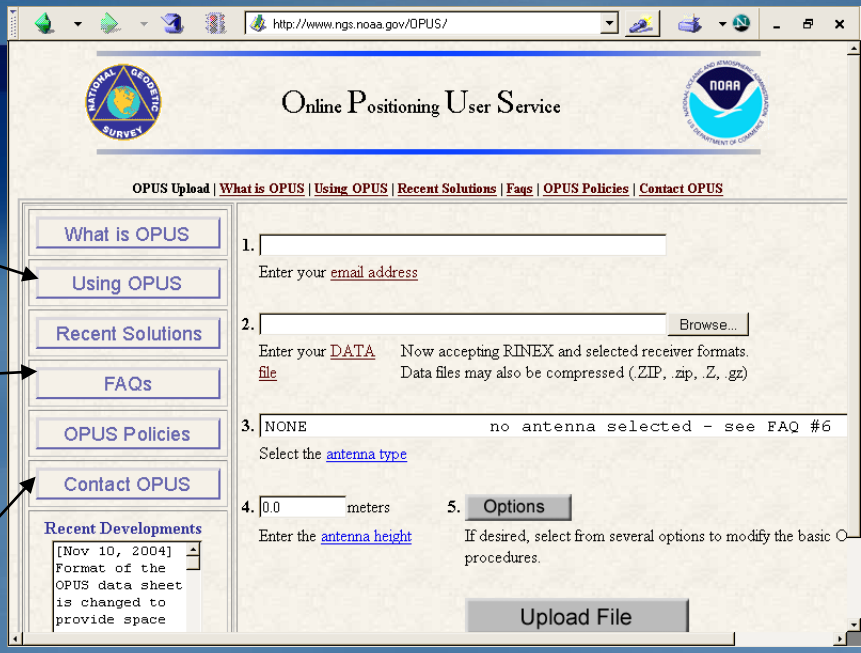
ERROR! Opus terminated abnormally in one of the processing modules.

How do I get help?

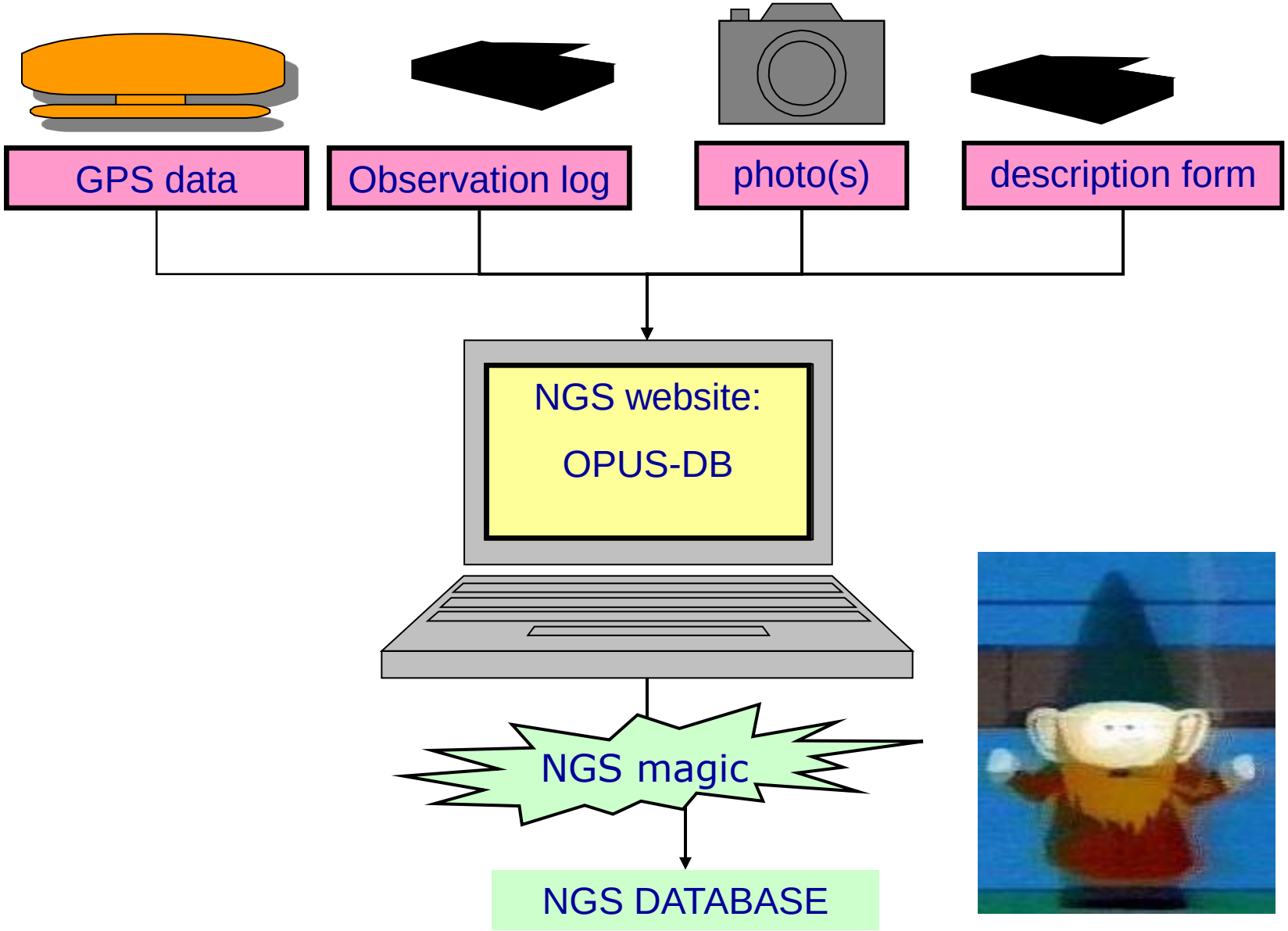
- Study the Guidelines under "Using OPUS"

- Study the answers under "FAQs"

- Submit specific questions, comments or suggestions using "Contact OPUS" link



OPUS-DB (OPUS-DataBase)



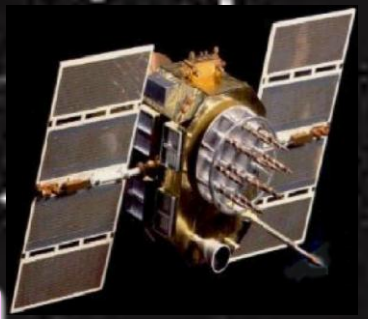
"OPUS DB" (Submitting OPUS Results) close to release

NATIONAL GEODETIC SURVEY

Beta version being tested; intended to be available soon.

OPUS solutions meeting certain *criteria* and accompanied by metadata describing the site may be eligible for publication on Data Sheets from the NGS Integrated Data Base (IDB). Users submitting to the IDB must be registered with NGS to receive a user ID and password and agree to the terms of this publication. Please review the *procedures* for IDB submission.

- The numerical criteria for an OPUS solution to be accepted for publication are:
- NGS calibrated GPS antenna
- minimum 4 hour data span
- minimum 90% observations used
- minimum 80% fixed ambiguities
- maximum 0.02m horizontal peak-to-peak
- maximum 0.04m vertical peak-to-peak



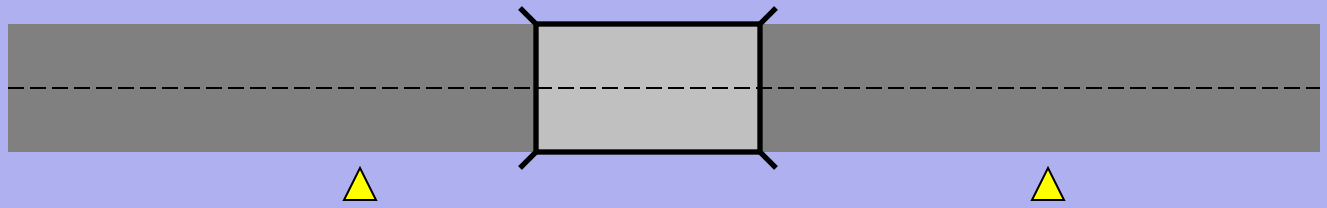
Demonstration

Application II

CONTROLLING A BRIDGE SURVEY

The accompanying slides were presented
at the
2002 CORS Forum
by
Gary Thompson
of the
North Carolina Geodetic Survey.

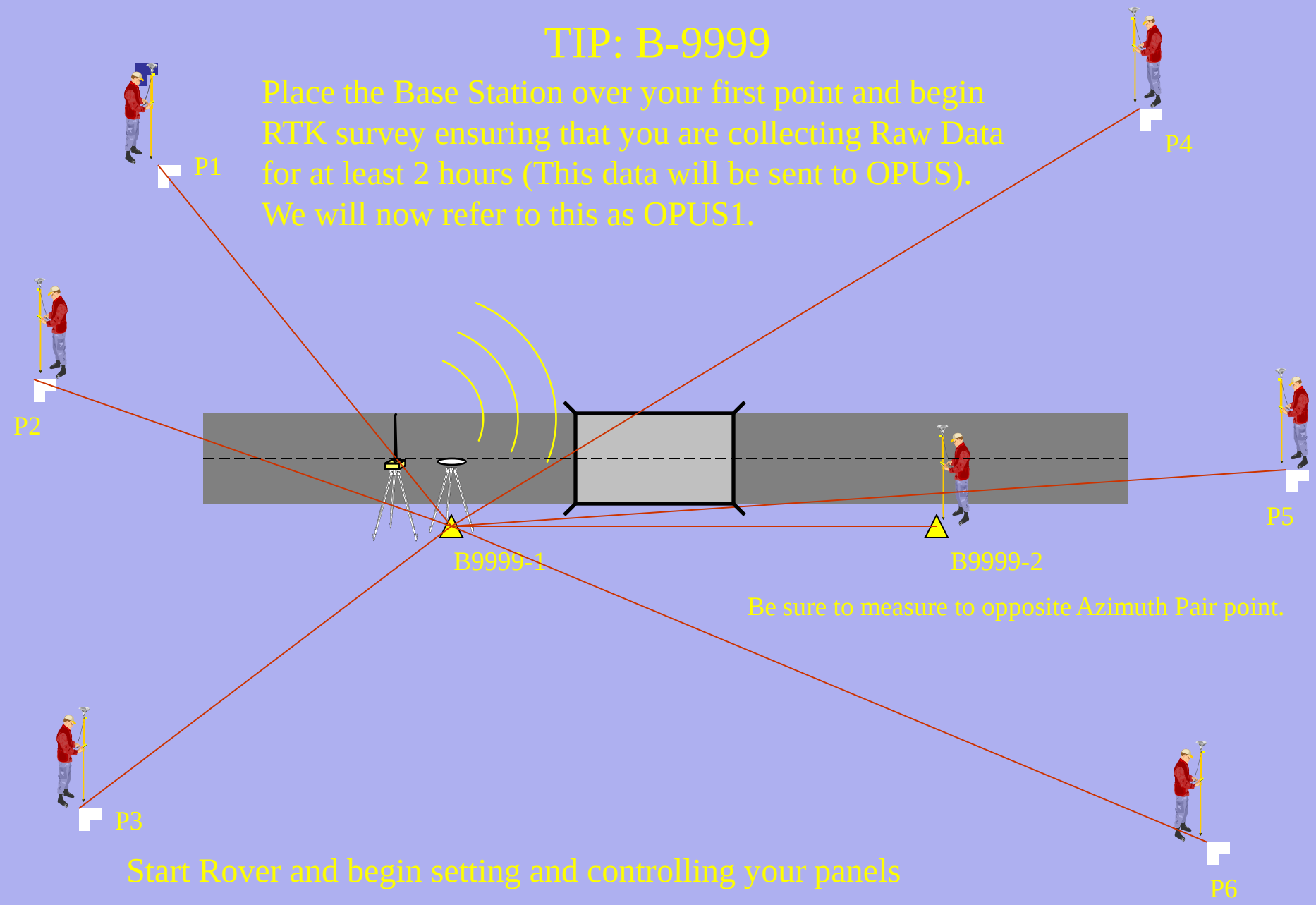
Using OPUS to control Bridges



- On a typical bridge job, NCDOT
  - Sets an azimuth pair (△ △)
  - Uses approximately 6-7 control panels ( )
  - Controls the site with 2 receivers

TIP: B-9999

Place the Base Station over your first point and begin RTK survey ensuring that you are collecting Raw Data for at least 2 hours (This data will be sent to OPUS). We will now refer to this as OPUS1.

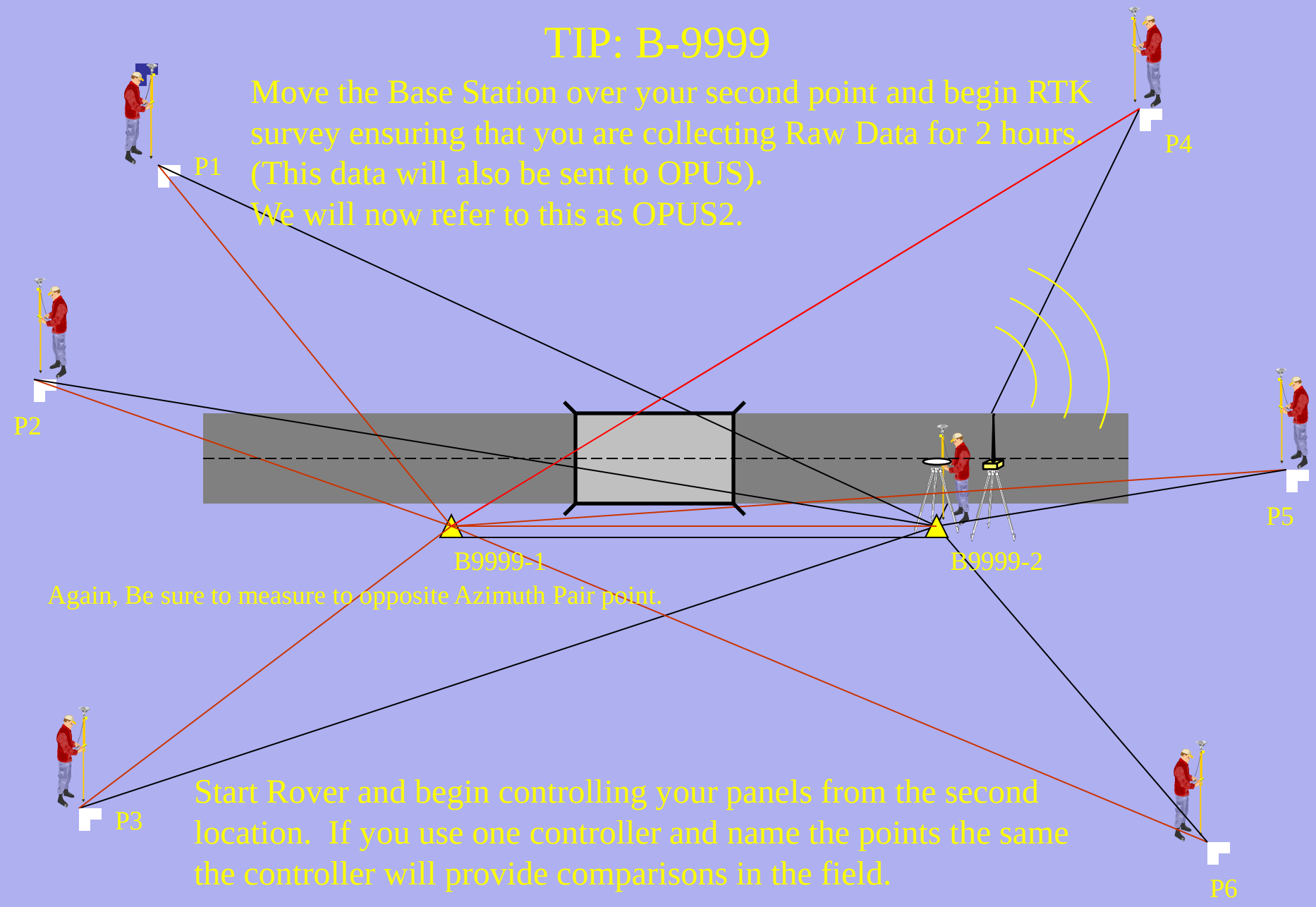


Be sure to measure to opposite Azimuth Pair point.

Start Rover and begin setting and controlling your panels

TIP: B-9999

Move the Base Station over your second point and begin RTK survey ensuring that you are collecting Raw Data for 2 hours. (This data will also be sent to OPUS).
We will now refer to this as OPUS2.



Again, Be sure to measure to opposite Azimuth Pair point.

Start Rover and begin controlling your panels from the second location. If you use one controller and name the points the same the controller will provide comparisons in the field.

Field Work is now complete.

The following steps need to be taken to finish the process:

Office Process

- Download the Raw Data and RTK dc files
- Convert both blocks of raw data to RINEX format using Trimble's utility
- Upload the files to: http://www.ngs.noaa.gov/OPUS/
- Receive the results from OPUS via email in minutes

Continued…

- Import the dc file into Trimble Geomatics Office
- Update the initial base position for the first base to the coordinates provided by OPUS1
- After a recompute, everything in the dc file should be corrected relative to the first base location (OPUS1)

Continued ...

- The position for OPUS2 is only used for comparison to what was derived from OPUS1
- Coordinates can now be utilized as needed

OPUS & RTK Savings to NCDOT

	Staff Hours	Vehicles	GPS Receivers	Cell Phones
Static	24 - 48	3	3	3
OPUS & RTK	6 - 12	1	2	*1
Savings	18 - 36	2	1	2

* The cell phone listed in the OPUS & RTK surveying comparison was not used in the survey work, but was available for contacting the office.

HOW IS THE ANTENNA HEIGHT MEASURED?

The height is measured vertically (NOT the slant height) from the mark to the ARP of the antenna. The height is measured in meters.

The ARP is almost always the center of the bottom-most, permanently attached, surface of the antenna.

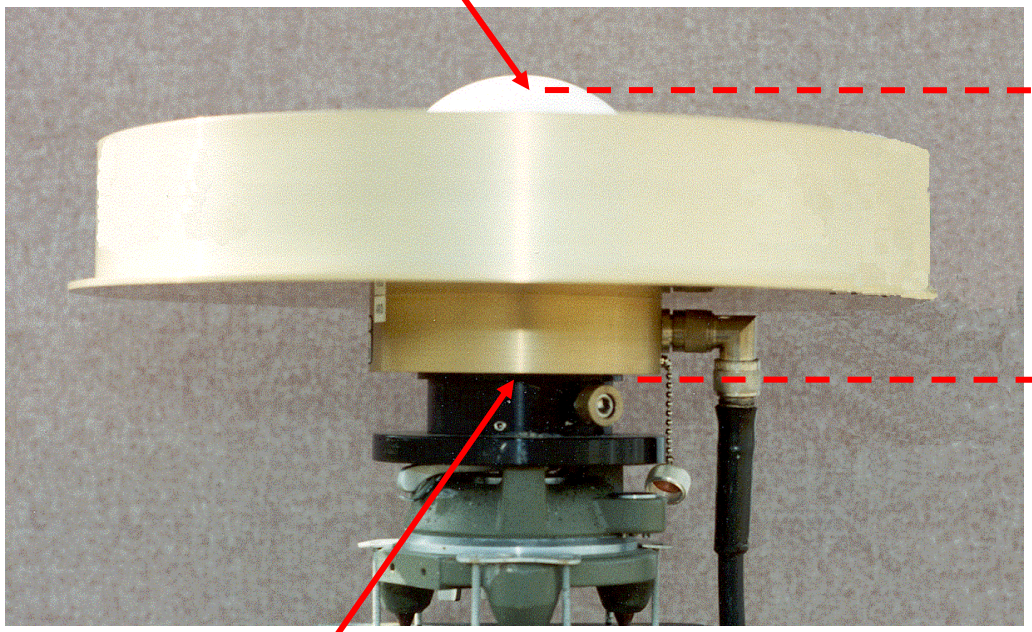
See GPS Antenna Calibration for photo's and diagrams that show where the ARP is on most antennas:

http://www.ngs.noaa.gov/ANTCAL/

If the default height of 0.0000 is entered, OPUS will return the position of the ARP.

WHY DO I NEED THE ANTENNA TYPE?

The antenna phase centers are located somewhere around



You do not need to know these offsets. They are passed to the processing software through the antenna type

The antenna offsets are the distance between the phase centers and the ARP

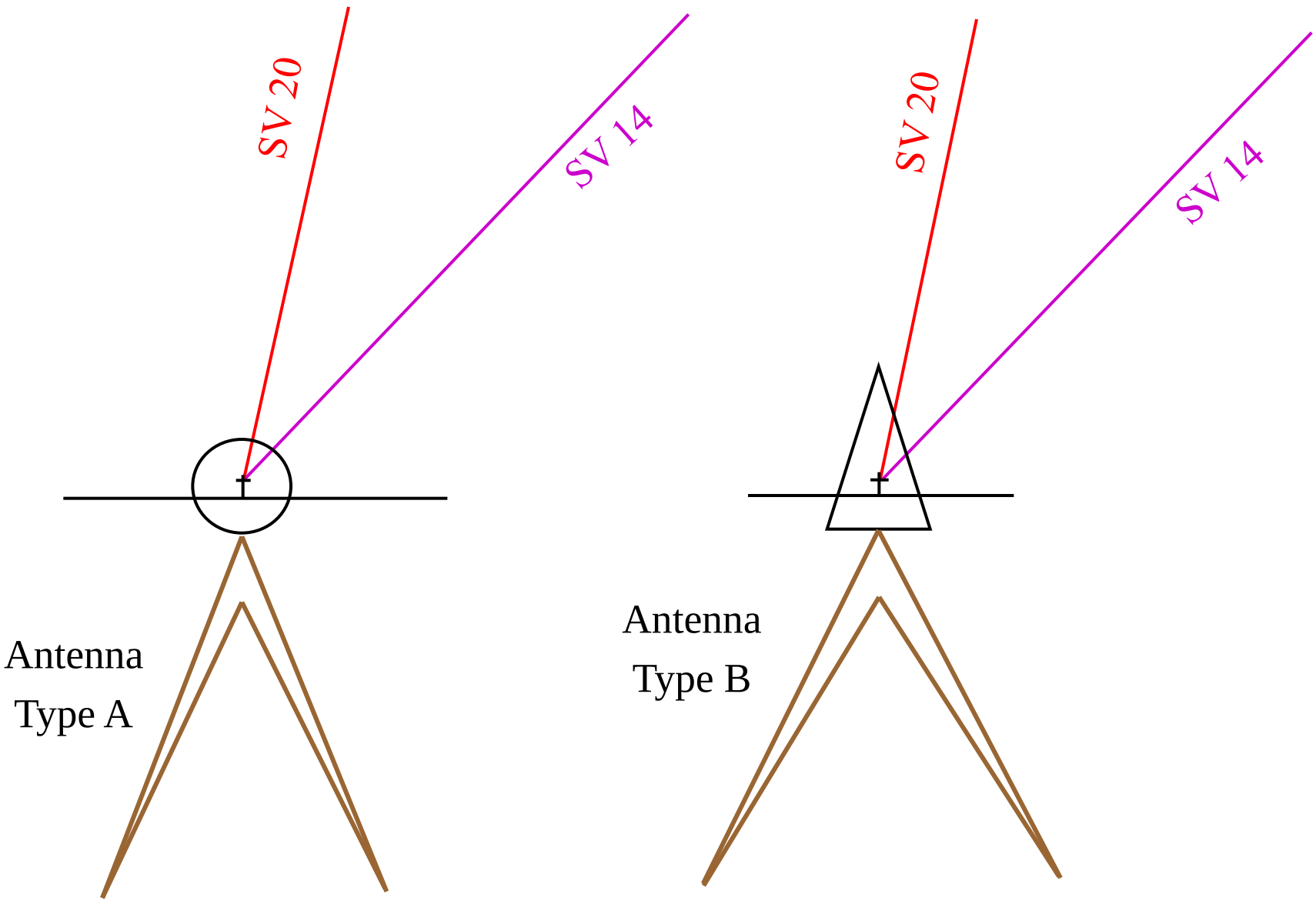
If the user selects NONE as the antenna type, the offsets are set to 0.000 and the antenna phase center becomes the reference

The Antenna Reference Point (ARP) is almost always located in the center of the bottom surface of the antenna.

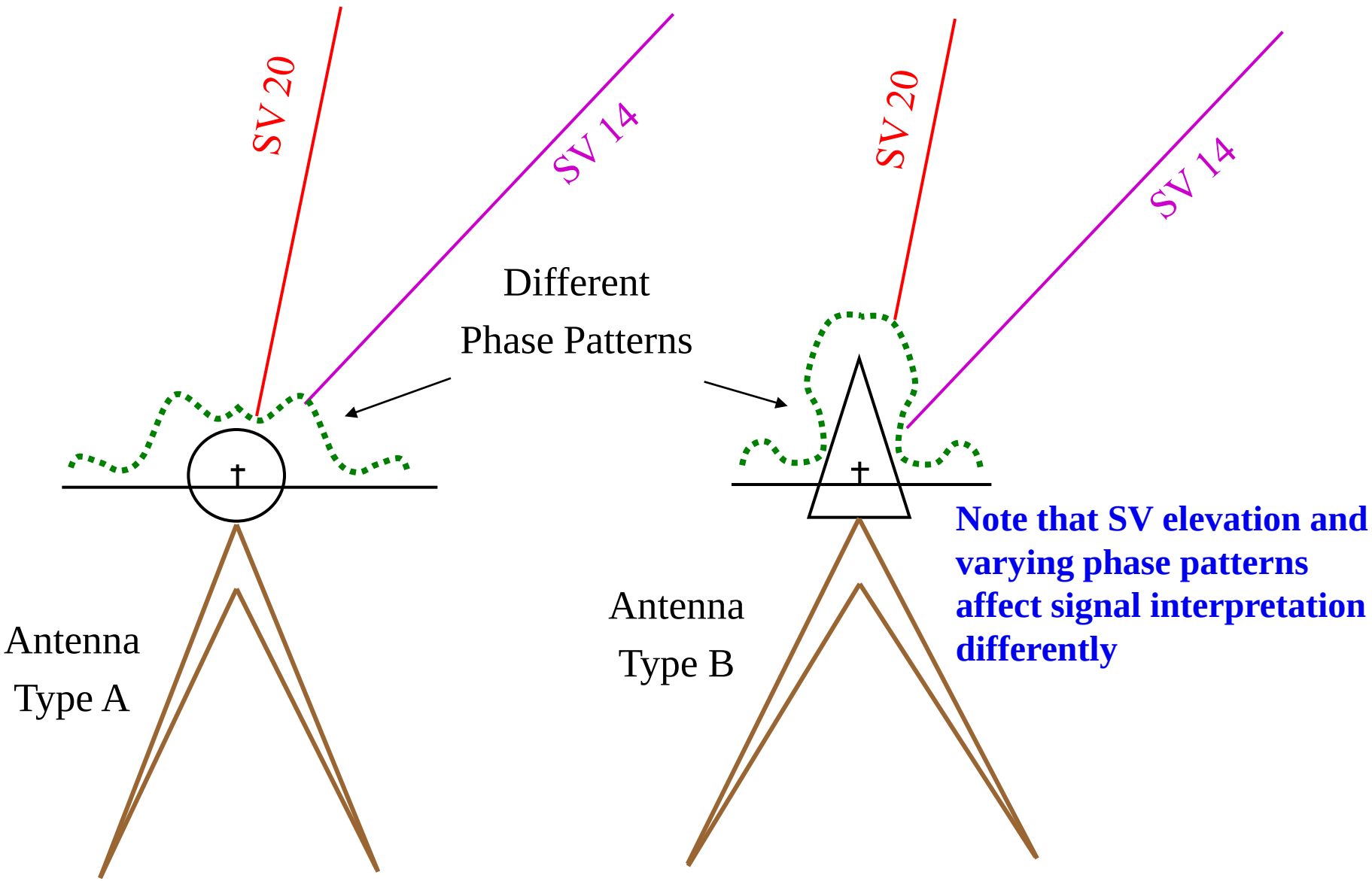
Incorrect or missing antenna type → big vertical errors

Antenna Calibration Facility in Corbin, Virginia

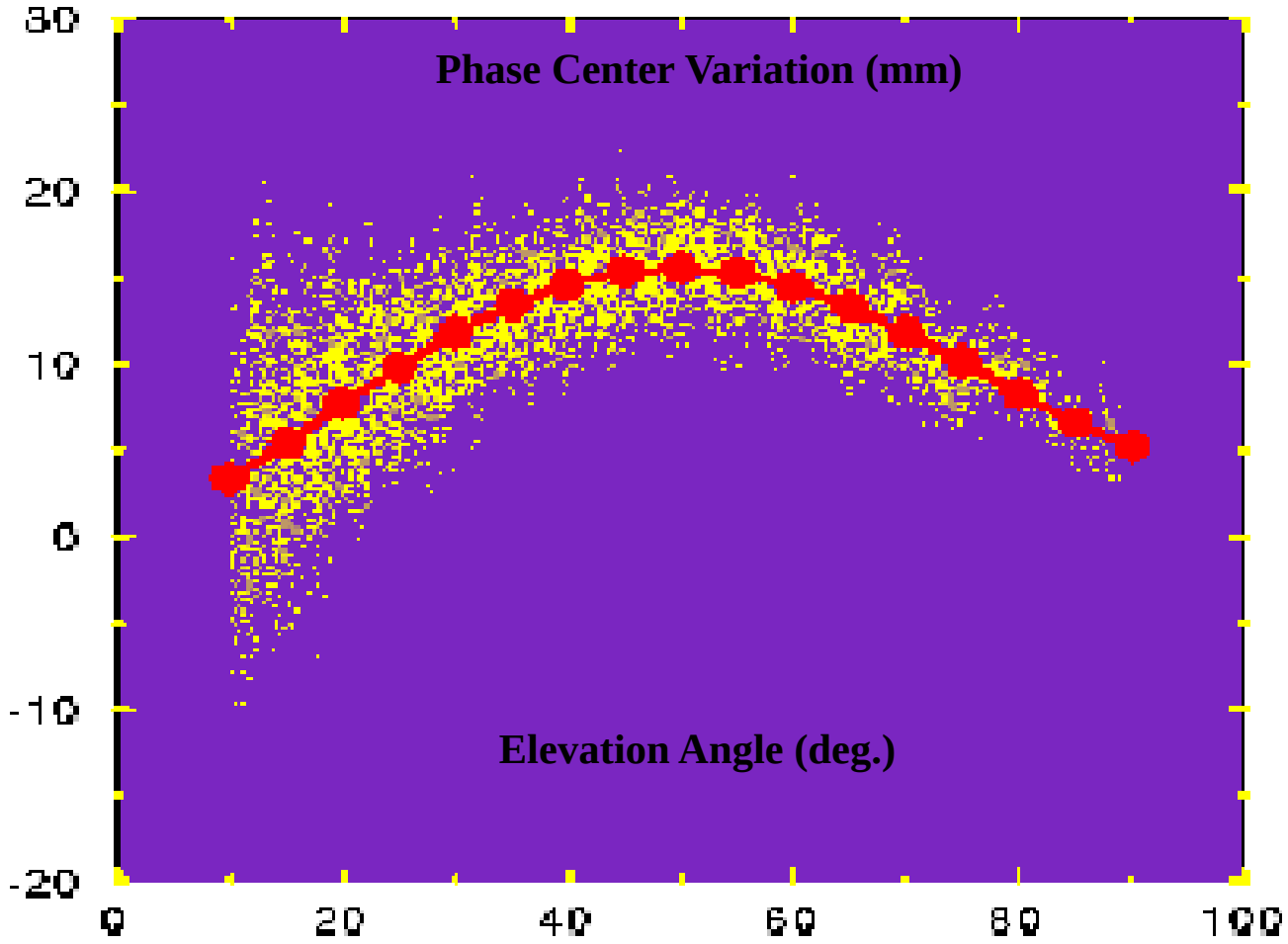
Antenna Phase Center Variation



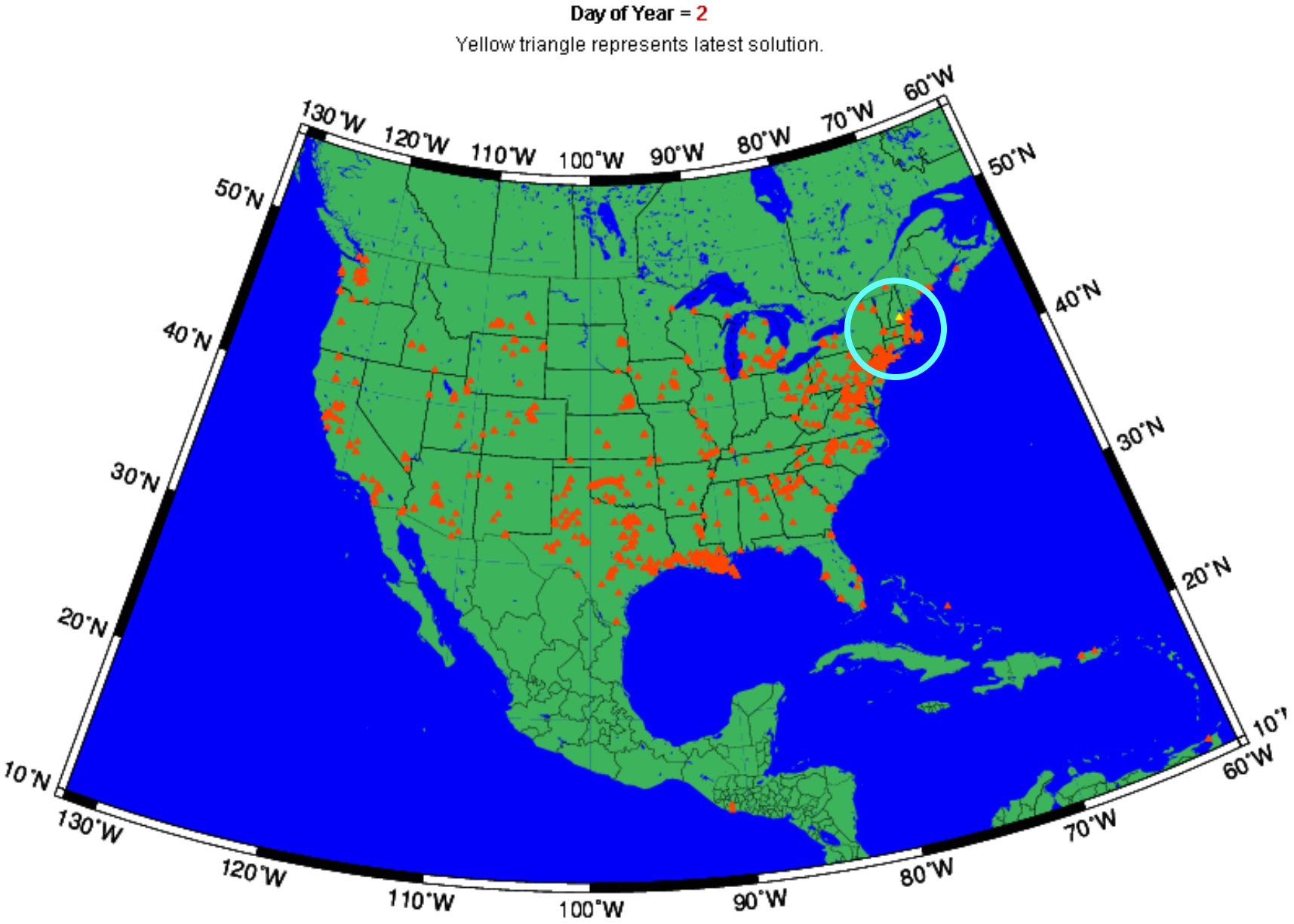
Antenna Phase Center Variation



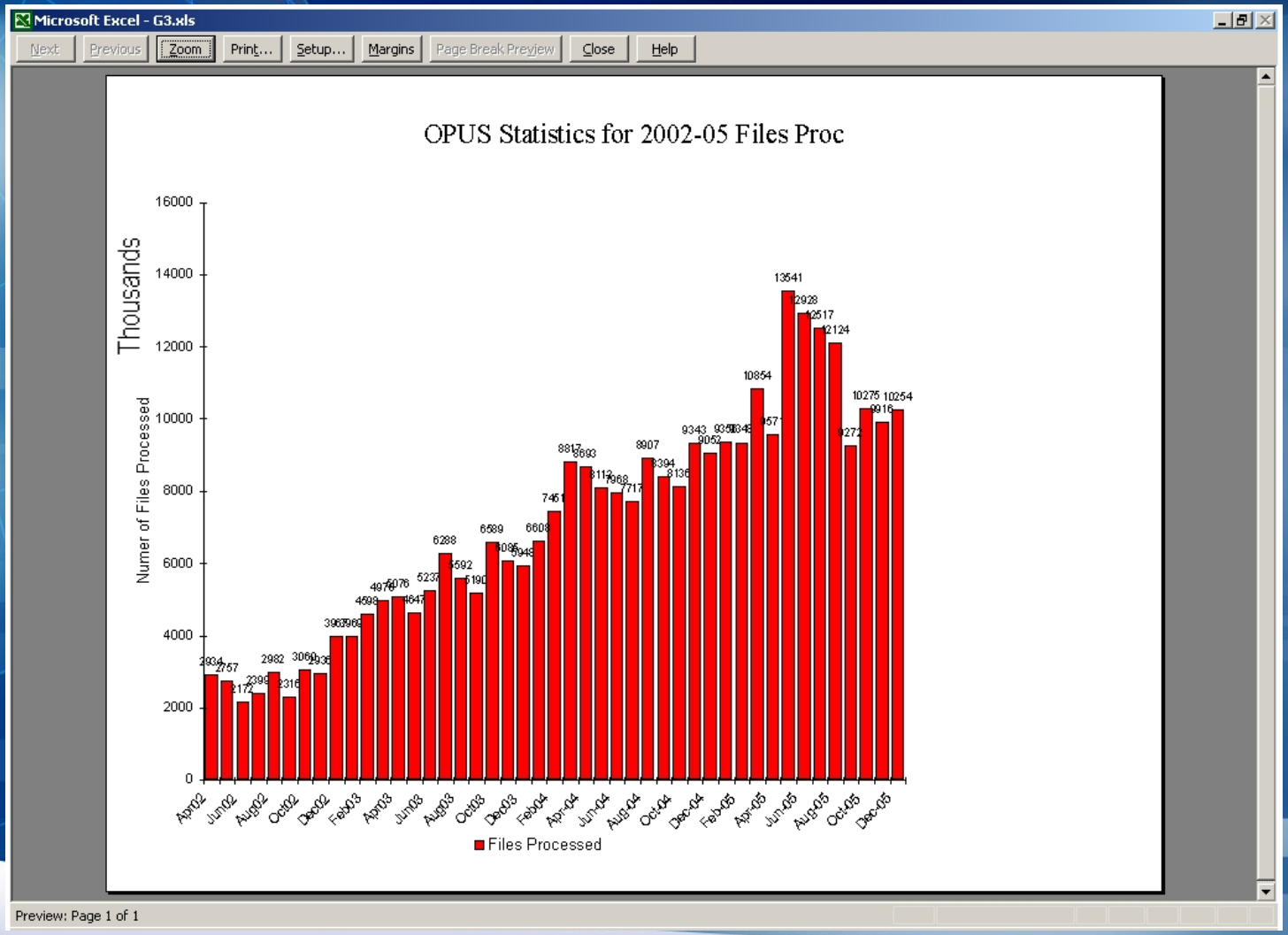
ELECTRONIC PHASE CENTER



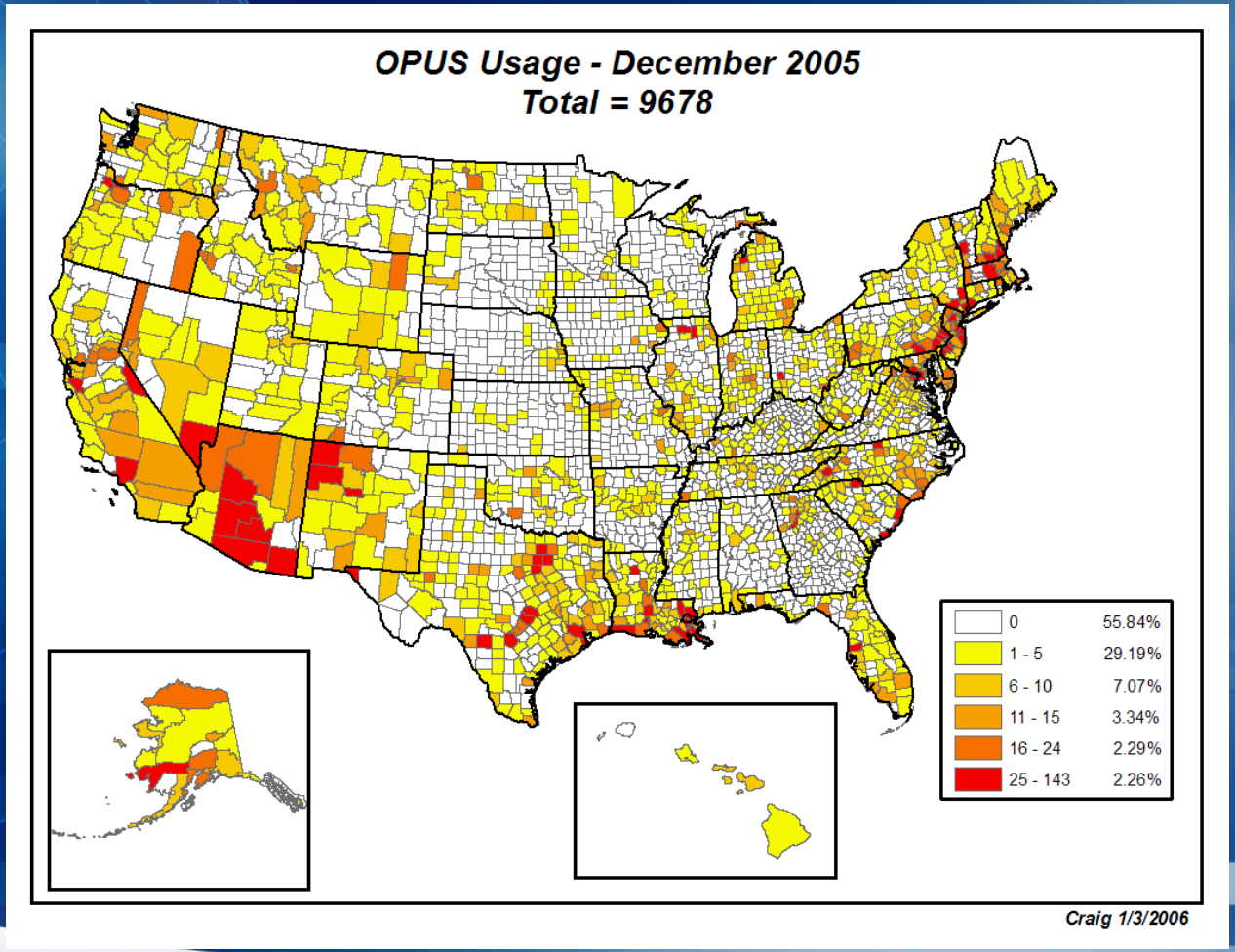
Recent Solutions



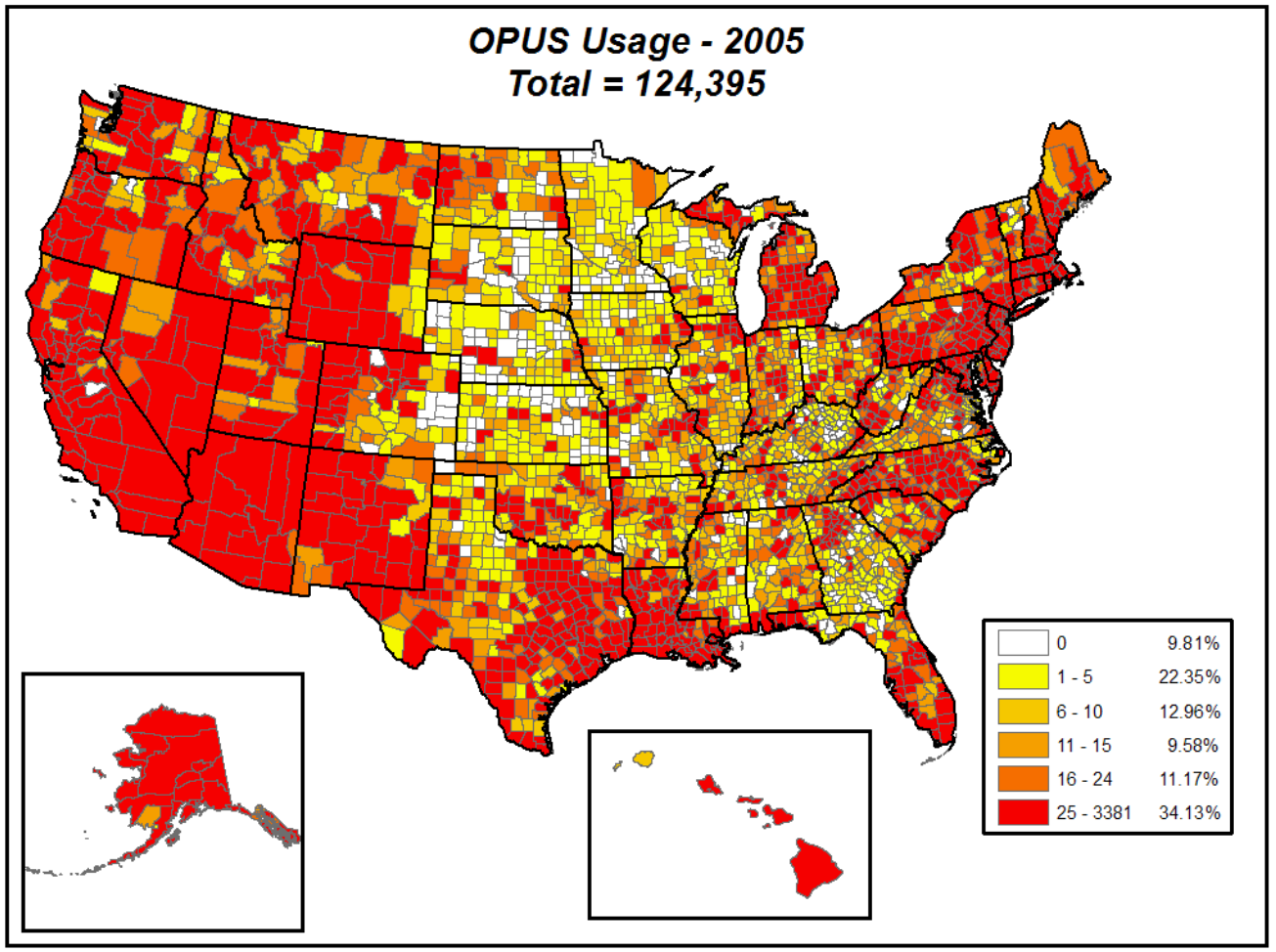
Files processed during even-numbered months, 2002-2005



OPUS usage for one month



Total OPUS usage during 2005



ONGOING CORS RESEARCH

NATIONAL GEODETIC SURVEY

* Exploring the use of NTRIP to stream GPS data from selected CORS via the Internet.

* Developing OPUS-GIS which will process a few minutes of GPS code range data (for sub-meter accuracy)

* Developing OPUS-RS (rapid static) that will enable users to obtain positional coordinates with cm-level accuracy using only 15 minutes of GPS carrier phase data

"OPUS Projects"—under long-term development

- OPUS files identified as belonging to a project are directed to appropriate directories
- Project data submission organized
- Reports sent to project managers
- Station data checked and edited as needed
- PAGES GPS processing accomplished
- ADJUST run